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U. S. ARMY TEST AND EVALUATION COMMAND
ENVIRONMENTAL TEST PROCEDURE

ARCTIC ENVIRONMENTAL TEST OF TRACKED AND WHEELED VEHICLES

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide a means of evaluating the suitability of tracked and wheeled vehicles in arctic winter environmental conditions.

2. BACKGROUND

Arctic testing of tracked wheeled vehicles is required to supplement and substantiate engineering and service test data acquired in temperate zone tests of these equipments. Specific tests, particularly of the engineering type will not be repeated unless results are expected to be materially different under arctic conditions. Primary emphasis is on testing under arctic winter conditions because of terrain conditions peculiar to the arctic regions of the world, a limited amount of testing is conducted under arctic summer conditions. Testing in extreme arctic winter conditions is generally not conducted until the vehicle has been evaluated under simulated climatic extremes (cold chambers). This simulated testing is used to develop starting procedures and check the operation of all components in temperatures down to -65°F. Testing in natural climatic environments is used to substantiate or supplement data obtained in the simulated tests. Results of arctic testing produce data required for type classification or reclassification and information essential for procurement or other logistical decisions. Specific test criteria for arctic testing are limited in scope and often vague in context. As a result, it is often necessary to compare a test vehicle with a similar one and present data in the form of a performance comparison rather than as a quanitative analysis of various performance factors.

3. REQUIRED EQUIPMENT

a. Test support equipment (equipment required to conduct testing are determined primarily by the nature of the item under test. Normally such equipment shall be found in the "Required Equipment" section of the applicable commodity MTP).

b. Instrumentation

1) Stopwatches and electric timers
2) Photographic equipment (black and white or color)
3) Tools and equipment as required
4) Oil sample test kits
5) Heater test stand
6) Fuel flow meter
7) Appropriate Arctic winter uniforms and individual field gear
8) Comparison vehicles as applicable

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c. Engineering test equipment (required for collection of engineering data).

d. Meteorological support equipment.

1) Temperature, measuring devices (thermometers, etc.)
2) Humidity measuring devices (psychrometers, etc.)
3) Atmospheric pressure measuring devices (barometers, etc.)
4) Precipitation measuring devices
5) Solar radiation counters
6) Wind speed and direction measuring devices
7) Ozone concentration measuring devices

4. REFERENCES

a. AR 705-15, Operation of Materiel Under Extreme Conditions of Environments.
b. AR 705-5, Army Research and Development.
c. AR 70-10, Army Materiel Testing.
d. USATECOM Regulation 705-2, Documenting, Test Plans and Reports.
e. HEL Technical Memorandum 21-62, Manual of Standard Practice for Human Factors in Military Vehicle Design, Aberdeen Proving Ground, Maryland.
f. Materiel Test Procedures

1) MTP 2-3-518, Line Haul Operation
2) MTP 2-2-602, Acceleration-Maximum and Minimum Speeds
3) MTP 2-2-603, Vehicle Fuel Consumption
4) MTP 2-2-604, Drawbar Pull
5) MTP 2-2-605, Towing Resistance
6) MTP 2-2-608, Braking
7) MTP 2-2-609, Steering
8) MTP 2-2-610, Gradeability and Side Slope Performance Mobility
9) MTP 2-2-612, Fording
10) MTP 2-2-707, Kits (Vehicle)
11) MTP 2-2-708, Personnel Heating Systems
12) MTP 2-2-802, Stowage
13) MTP 10-4-500, Arctic Preoperational Inspection, Physical Characteristics, Human Factors, Safety and Maintenance Evaluation

5. SCOPE

5.1 SUMMARY

The procedures outlined in this MTP are designed to determine and evaluate the functioning characteristics of tracked and wheeled vehicles under arctic winter environmental conditions. Specific subtests include:

a. Preoperational Inspection and Physical Characteristics - The objectives of this subtest are to:

1) Determine if the test and comparison items are in proper condition for testing.

2) Install Instrumentation
3) Perform necessary maintenance to connect malfunction discovered during this inspection.
4) Determine if the test item's physical characteristics conform to the applicable criteria.

b. Operational Suitability-The objective of this subtest is to evaluate the operational suitability of tracked and wheeled vehicles in terms of the following:

1) Cold start
2) Crew heater system
3) Special purpose kits
4) Stowage
5) Compatibility with related equipment
6) Functional suitability
7) Security from detection
8) Weapons kits

c. Performance characteristics - The objective of this subtest is to evaluate the performance characteristics of the test item in terms of the following:

1) Fuel and oil consumption
2) Fuel and lubricant analysis
3) Tractive capability
4) Slope performance

d. Mobility - The objective of this subtest is to evaluate the mobility of the test item in an arctic environment, in terms of the following:

1) Road mobility
2) Cross country mobility
3) Inland waterways
4) Fording

e. Human Factors Evaluation and Safety - The objective of this subtest is to determine the effectiveness of human factors design aspects of the vehicles under test and to verify the safety features of these vehicles.

f. Maintenance - The objective of this subtest is to determine the maintenance requirements for test vehicles, engendered or aggravated by their use in an arctic environment, and to determine whether these test item maintenance requirements meet maintenance and maintainability standards as defined by QMR's TC's, SDR's, or other established criteria.

5.2 LIMITATIONS

a. Throughout this MTP, the term "vehicle" is limited to combat and transport vehicles. Construction equipment is not included because of the peculiar technical characteristics possessed by such items.

b. The tests contained herein do not constitute detailed test plans. Each test activity must make their own judgment as to the applicability of each test and must determine how to best obtain the required data for each vehicle undergoing test. Requirements found in some Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC's), may necessitate the conduct of tests not found in this MTP to ensure compliance with all requirements, in which case other MTP's or similar guidance will be used in formulating test plans.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 General Preparations

a. Arctic winter environmental tests are normally scheduled from October through March (6 months). Tests, test comparison and support weapons should be delivered to the arctic test center prior to 1 October.

b. TDY Personnel will be used to augment assigned personnel and will be trained to the degree that they are as proficient using the test item as the troops who will use the test item.

c. Ensure that all test personnel are familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC's) and record this criteria in the test plan.

d. Review all instructional material issued with the test item by the manufacturer, contractor, or government, as well as reports of previous tests conducted on the same type of equipment, and familiarize all test personnel with the contents of such documents. These documents shall be kept readily available for reference.

e. Record the grade, MOS, background, and training of all test personnel and ensure that all personnel receive new equipment training (NET) as required.

f. Record the following information:

1) Nomenclature, serial number(s), and manufacturer's name of the test items.
2) Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

g. Select test equipment having an accuracy of at least 10 times greater than that of the function to be measured.

h. Prepare record forms for systematic entry of data, chronology of test, and analysis in final evaluation.

i. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the test.

j. Record the prevailing meteorological conditions during the storage phase, as well as test conduct, to include:

1) Temperature
2) Humidity, relative or absolute
3) Temperature gradient
4) Atmospheric pressure
5) Precipitation
6) Solar radiation
7) Wind speed and direction
8) Frequency of readings
9) Source of data

6.1.2 Test Item Preparations

Prior to beginning environmental tests, a preoperational inspection and physical characteristics test shall be performed on the test item in accordance with procedures outlined in MTP 10-4-500.

6.1.3 Test Personnel Training Preparations

Training of test personnel on standard vehicles will normally be conducted by the assigned project officer utilizing the test vehicle. In the case of new equipment which required special training, personnel will be sent to other test centers in CONUS or to the developer's facility for special training. This training will include operation and maintenance of the test vehicle. Maintenance personnel will also undergo similar training, with emphasis on maintenance, if the test vehicle is of a new or non-standard type. If feasible, the test vehicle should be shipped to the Arctic Test Center early enough so that on-site training can be substituted for the training described above. Personnel from CONUS or the developer will normally conduct this training on a temporary duty basis.

6.2 TEST CONDUCT

6.2.1 General

a. During all testing the vehicle shall be operated in as wide a range of temperatures as available. During winter testing attempts shall be made to accumulate data and compare performance in ambient air temperature between 0°F to -25°F, and below -25°F to the lowest ambient air temperature available. The length of cold-soak periods and ambient air temperatures during cold-soak periods will be recorded during each subtest, as appropriate.

b. When not undergoing tests, the vehicle shall be stored outdoors and exposed to prevailing weather conditions, except when indoor maintenance is required.

c. In all operational tests the test vehicle shall carry the equivalent of its full combat load or rated payload unless indicated otherwise.

d. The tests described herein are not intended to duplicate engineering tests conducted by another activity. Any test for which engineering data is available in completed engineering reports may be omitted if the data is independent of temperature.

e. Whenever practical test operations shall be conducted on a combined basis in order to avoid unnecessary duplication.

f. Still and motion pictures shall be taken as appropriate to illustrate test results.

g. Test operations shall be continued regardless of adverse weather conditions, except when such conditions will compromise test results to endanger life or property.

h. All testing, operation and servicing of the test vehicle and components shall be in accordance with instructions contained in appropriate technical manuals or other publications.

i. If the test vehicle is intended to replace a standard vehicle, the standard vehicle shall be used as a comparison vehicle during selected tests, especially operational tests.

j. Throughout the conduct of tests, a determination shall be made of any unnecessary, costly or nice-to-have features that may be eliminated without adversely effecting essential performance requirements, reliability, quality or safety.

k. Testing shall not be conducted until a safety release is issued by U. S. Army Test and Evaluation Command. The safety release shall contain as a minimum, information pertaining to operational limitations and specific hazards peculiar to the vehicle or components thereof.

6.2.2 Preoperational Inspection and Physical Characteristics

a. Upon receipt, carefully inspect all test items and comparison weapons and their shipping or packaging containers for completeness, damage and general conditions in accordance with the applicable sections of MTP 10-4-500.

b. Perform necessary maintenance to connect deficiencies and shortcomings noted during this inspection.

c. Install instrumentation required.

d. Take vehicle identification photographs.

6.2.3 Operational Suitability

6.2.3.1 Cold Starting

6.2.3.1.1 Engineering Cold Starts - During all engineering cold start tests, the following general procedures shall apply:

a. Cold soak the test vehicle until engine oil sump temperature is within ± 5°F of the ambient air temperature.

NOTE: Stabilization of vehicle components at ambient temperatures during cold soak operations shall be accelerated except during stand by heater operations, by the use of an external blower, with all hatches, vents, etc. open.

b. Cold start the test vehicle, upon completion of cold-soaking, utilizing the starting procedure recommended in the test item's operation manual or other applicable document.

NOTE 1: If the test vehicle fails to start within 120 seconds total cranking time, the test engineer shall sttempt to develop a better starting procedure by systematically varying the recommended procedure.

NOTE 2: The batteries of the test vehicle shall be used to cold start the test vehicle only when they are at 75-100% full charge. The charge shall be determined by use of a battery electrolyte hydrometer or battery charger analyzer. If such batteries are not available, an external source of electricity (slave) shall be used.

c. Measure and record the following data:

1) Ambient meteorological conditions present during starting attempts.
2) Component temperatures and pressures prior to and during cold start and warmup.
3) Electrolyte temperature and state of charge of batteries prior to cold start.
4) Electrical power requirements during cold start.
5) Cranking speed, time to first fire, number of starting attempts and time to smooth operation.
6) Presence of smoke engine noise or roughness.
7) Techniques used by the driver during cold start (throttle and choke positions).
8) Length of cold soak.
9) Total cranking time.

d. Cold-soak the test vehicle in ambient temperatures of -25°F to the lowest available temperature for a maximum period of 16 hours.

e. During the above cold-soaking, employ the arctic winterization kit as a standby heater system with all hatches closed.

NOTE: If the vehicle is not provided with standby heater, (arctic kit) omit the procedures of d and e above.

f. Repeat step b above.

g. Repeat step c above.

h. Cold-soak the test item until engine oil sump temperature is within ±5°F of the ambient air temperature.

i. After the above cold-soaking period employ the arctic kit as a quick heat (pre-heat) system.

j. Repeat step b above.

k. Repeat step c above.

NOTE: The above procedures apply in general to all test vehicles. In the event a vehicle is equipped with a peculiar arctic kit, it may be necessary to modify the procedures.

6.2.3.1.2 Service Cold Starts - During all service cold starts, the following procedures shall apply:

NOTE: The service cold-start subtest shall be performed during the conduct of other subtests, whenever the test vehicle is started in ambient temperatures below 0°F.

a. When performing other subtests on the test vehicle use the starting procedure recommended by the manufacturer or in the operator's manual to start the test vehicle.

NOTE: If the test vehicle fails to start, and external slave source will be used.

b. Measure and record the following data during starting:

1) Ambient temperature during starting attempt.
2) Engine oil sump temperature prior to start.
3) Battery electrolyte specific gravity.
4) Total cranking time.
5) Driver techniques during starting.
6) Length or cold-soak and average ambient air temperature during the cold-soak.
7) Length of preheat or length of standby heater operation.

6.2.3.1.3 Cool down rate - The following procedures shall apply:

a. Operate the test vehicle for a period sufficient for stabilizing the engine, drive train and crew compartment at normal operating temperatures.
b. Instrument the test vehicle to obtain temperature measurements of selected vehicular components.
c. Stop the test vehicle and determine and record initial temperature measurements of the selected vehicular components and ambient meteorological conditions.
d. Periodically, measure and record the temperature of the selected vehicular components until ambient temperatures are reached.
e. Measure and record the length of time for cool down.

6.2.3.1.4 GENERAL: All failures of winterization kit components will be recorded. Individual cold start tests should be conducted throughout the winter test season in order to determine if there is any change in starting characteristics after the test vehicle has been subjected to durability mileage tests. In the event more than one vehicle is available for test, all vehicles should be cold started to increase the data base. All mechanical components will be placed in the best possible running condition prior to all tests. Any mechanical difficulty which might have an effect on cold starting capability must be inspected a minimum of once per week to ensure that erroneous data is not collected because of defective instrumentation.

6.2.3.2 Suitability of Crew Heater System

a. Instrument test item to collect indicated data regarding the following:

1) Fuel Fired Heaters

(a) Heater inlet air temperature
(b) Heater outlet air temperature
(c) Heater fresh air outlet static pressure
(d) Heater exhaust static pressure
(e) Blower motor current
(f) Fuel flow rate

2) Hot water heaters

(a) Coolant temperature at heater inlet
(b) Coolant temperature at heater outlet
(c) Air outlet temperature
(d) Blower motor current

3) Defrosters:

(a) [illegible]cent of windshield defrosted at 5-minute intervals.
(b) [illegible] temperature at defroster outlet

4) Vehicle speed during mobile tests
5) Ambient meteorological conditions
6) Total hours of operation of each heater and temperature setting used
7) Air temperature in compartments at feet, hands, and face level.

b. Inspect heaters to be tested, for proper functioning and to ensure that all adjustments are correct.

NOTE: The two general types of personnel heaters are fuel fired air heaters and hot water heaters which use the engine coolant as a heat source. Engine coolant, standby heaters are not included in this subtest.

c. Operate the heaters with the test vehicle stationary and with the engine on.

d. Measure and record data listed in a.,1 through 7, above, as applicable.

e. Operate heaters with test vehicle stationary and engine off.

f. Repeat d. above.

g. Operate heaters with the test vehicle moving at 15-25 miles per hour.

h. Repeat d. above.

i. Repeat procedures c through h a minimum of five times in two temperature ranges, (0°F to -25°F and -25°F to the lowest ambient air temperature available), and with normal crew capacity and with vehicle compartments empty.

NOTE 1: All compartment openings shall be closed during these tests and the heaters will be operated on high heat output.

NOTE 2: Defroster tests will be run with the vehicle both static and mobile. Data will be recorded every 5 minutes until the window is 75 percent defrosted. Acetate divided into 100 grid squares will be placed over the windshield when determining percent of area defrosted. Crewmen will remain in the vehicle during the test. Photographs will be taken to provide graphic results of the test.

6.2.3.3 Suitability of Special Purpose Kits

All standard or developmental kits shall be tested in conjunction with overall testing of the vehicle on which they are mounted in the following manner:

a. Install all special purpose kits not installed on the vehicle when it is delivered to the Arctic Test Center.

NOTE: Maintenance personnel at the level prescribed by the applicable QMR, SDR, or other pertinent directive shall perform kit installations.

b. Record the time tools and echelon of maintenance required to perform the installation.

c. Operate the test vehicle over various types of terrain including highways, secondary roads, and cross-country, with special purpose kits installed.

d. Observe and record the following concerning suitability of kits, during the operation of the test vehicle:

1) Compatibility of the kit(s) and mount(s) with the test vehicle.
2) Compatibility of any required combinations of kits.
3) Adequacy of installation, operation and maintenance instructions.
4) Adequacy of mounting provisions.
5) Human factors engineering principles utilized in design of the kit(s). (See MTP 10-4-500).
6) Any degradation in performance, durability and reliability of the test vehicle caused by kits. (See MTP 10-4-500).

NOTE 1: If there are a large number of kits for a test vehicle it will be necessary to include a subtest for each in the plan of test.

NOTE 2: Kits not applicable to the arctic environment will not normally be tested. Particular emphasis will be placed on the evaluation of any kits designed exclusively for use in the arctic.

e. Record the following additional data as applicable during this subtest:

1) Record number of miles accumulated by the test vehicle on highways, secondary roads and cross-country with kits installed.
2) Record the number of hours of operation of kits.
3) Record the use of the kits during operation.
4) Record observations pertaining to the following:

   (a) Compatibility of kit(s) with the test vehicle and other kits.
   (b) Adequacy of instructions.
   (c) Adequacy of mounting provisions.
   (d) Any human factors engineering problems encountered.
   (e) Any degradation in performance, durability and reliability of the test vehicle attributable to the kit(s).

5) Record the engineering test data required to evaluate the kit.

6.2.3.4 Stowage

a. Prepare a list of all equipment to be carried on the test vehicle, including all TO & E and T/A equipment, OEM, ammunition, rations, typical payloads, etc.

b. Load the test vehicle with all equipment included on the list and operate the vehicle in its functional role.

NOTE: When specific items of materiel are not available, they will be simulated as nearly as possible in configuration and weight.

c. Observe and record whether the following occur during functional operation of the test vehicle:

1) Stowage interferes with operation of the vehicle.
2) Brackets, containers, tiedown points and other stowage provisions are adequate and accessible.
3) Provisions are made for the stowage of individual weapons and if they are accessible for immediate use.
4) Compartments for forms and manuals are present and adequate.
5) Personnel items such as binoculars, first aid kits, etc., are within easy reach of the crew.
6) Ammunition location guarantees ease of removing rounds from vehicle racks or bins.
7) All stowage locations drain properly when the test vehicle is level.
8) The interior of the test vehicle is free of items that should be stowed externally such as power tools, tow cables, etc.
9) Stowed item locations assure complete accessibility to various catches and releasing devices on the test vehicle.

10) Flammable items such as bedrolls, camouflage nets and tarpaulins are stowed where they are not likely to be ignited by carelessly thrown cigarettes or hot vehicle components such as engine exhausts, etc.
11) Stowage locations interfere with armament operation, to include recoil, ability to load and maximum gun travel either in elevation or depression.
12) Provisions are provided to stow the additional equipment required for arctic winter operations.
13) Stowage provisions interfere with the activities of crewmembers when wearing the arctic winter uniform.

6.2.3.5 Compatibility with Related Equipment

NOTE: If comparison vehicles are used during this test, all data recorded for the test vehicle shall be recorded for the comparison vehicle. Additionally, both vehicles shall be operated at the same time in the same area to assure valid comparison data.

a. Determine and record meteorological conditions present at the beginning of and during testing.
b. Observe and record the terrain and muskeg (snow) conditions.
c. Use the test vehicle to tow similar and lighter vehicles over secondary roads and cross-country terrain as deemed appropriate.
d. Observe and record the following concerning towing operations:

1) Ability of test vehicle to tow similar and lighter vehicles.
2) Any difficulties encountered in operating with towed loads, if applicable.

e. Immobilize the test vehicle in Muskeg (summer) or deep snow. (in winter).
f. Recover the test vehicle from the immobilized position and tow over secondary roads and cross country terrain as deemed appropriate, utilizing appropriate recovery vehicles or wreckers.
g. Observe and record the following regarding recovery operations:

1) The ability of suitable recovery vehicles to recover and tow the test vehicle.
2) Any difficulties encountered in operating with recovered loads, if applicable.

h. Substitute the test vehicle for the vehicle being towed and repeat steps c and d above.
i. Observe and record, throughout all phases of this subtest, all data regarding the following:

1) Ease of operation
2) Adequacy of coupling provisions

3) Interference with air and electrical lines
4) Interference with turns
5) General compatibility of the vehicle with towed loads.

NOTE: Towing and recovery operations will be conducted under adverse weather and terrain conditions to impose maximum requirements on the power components of the towing vehicle and on towing connections. Operation will be conducted during the summer and winter. Winter temperatures will be below -25°F before initiating the test.

6.2.3.6 Functional Suitability

NOTE 1: Comparison vehicles may be used during this test. If used, they shall be operated at the same time as the test vehicle to determine comparative advantages or disadvantages of the test vehicle.

NOTE 2: This subtest shall be conducted during arctic summer months (June-August) for summer tests and in temperatures below -25°F for winter tests. The most severe weather conditions normally encountered at the Arctic Test Center should be used for conducting this test.

6.2.3.6.1 Combat Vehicles - The following shall apply:

a. Prepare a scenario in order to make the best use of available test areas and terrain.

NOTE 1: If a mission narrative or operational cycle is available for the test vehicle, it should be followed in developing the test scenario.

NOTE 2: Whenever possible, the test vehicle shall be tested in conjunction with other tactical and administrative vehicles to add realism to testing. The test vehicle shall be fully loaded (stowed) for this test.

b. Operate the test vehicle during maneuvers or a simulated tactical exercise for the required mission duration.

c. During the operation phase, perform the following functions:

1) Fire all vehicle weapons.
2) Perform maintenance of the vehicle in the field.
3) Perform operations requiring crew to remain in the test vehicle for extended periods of time.
4) Perform tactical operations including offensive and defensive missions.
5) Perform night operations including:

(a) Servicing test vehicle

b) Resupply of ammunition.
c) Firing of vehicular weapons using night sights and other firing aids, including night vision devices.
d) Blackout operations (road march) with and without night vision devices.
e) Blackout cross country movement with and without night vision devices.

6) Perform fording operations
7) Perform operations requiring wearing of the protective mask for a period of four continuous hours including firing of weapons while masked.

d. Record the following:

1) Descriptions of missions performed.
2) Meteorological and terrain characteristics present during testing.
3) Results of missions performed.
4) Difficulties encountered in performing missions.

e. Question crew after performance of each individual task and record comments.

6.2.3.6.2 Logistics or Administrative Vehicles - The following procedures shall apply:

a. Prepare a scenario to assure that all functions of the test vehicle are covered.

NOTE 1: If a mission narrative or operational cycle is available for the test vehicle, it will be followed in the preparation of the scenario.

NOTE 2: Throughout the conduct of this test, the test vehicle shall be fully loaded (stowed).

b. Operate the test vehicle in the logistical or administrative role for which it is designed.

c. During the operation phase, perform the following:

1) Loading and unloading of various cargo loads (day and night).
2) Occupation of assembly areas.
3) Daylight convoy operation.
4) Blackout road convoy operation with and without night vision devices.
5) Blackout cross-country movement with and without night vision devices.
6) Loading, transporting and dismounting combat equipped troops.

7) Fording and negotiation of inland waterways in summer if applicable.
8) Operation of the test vehicle with the crew wearing protective masks.
9) Servicing of the test vehicle in the field.

d. Observe and record data as directed in paragraph 6.2.3.6.1, d.
e. Perform according to paragraph 6.2.3.6.1, e.

NOTE: This test is not intended to be a repetition of other subtests; however, much of the data collected will be reported under other subtests. Examples are Human Factors Engineering and Safety, Maintainability, Reliability and Durability, Cross-Country Mobility, Road Mobility, Fuel and Oil Consumption, Stowage, Fording, Inland Waterways Operation, etc.

6.2.3.7 Security from Detection

NOTE 1: This subtest will not be conducted during summer testing because detection distances will be no different from those experienced in temperate zone testings. It will not be conducted during winter months unless specifically directed by U. S. Army Test and Evaluation Command or requested by the agency for which the test is being conducted.

NOTE 2: The test vehicle will be operated in an isolated area to determine visual and aural security in comparison with a standard or similar vehicle. Testing will be conducted in temperatures below -25°F at night. The vehicles will be operated blacked out with the exception of necessary instrument lights.

a. Position the test vehicles in an isolated area where it can neither be seen nor heard.
b. Position a jury composed of a minimum of six personnel at an appropriate distance where they can neither see nor hear the positioned test vehicle.
c. Start the test vehicle and allow it to idle.
d. Direct the jury to move toward the vehicles until the vehicle is detected visually.
e. Observe and record the distance from the vehicle that detection occurs.
f. Return jury to their original position.
g. Repeat step d above until the vehicle is detected aurally.
h. Repeat steps e and f above.
i. Place the test vehicle in the prescribed gear range and at the designated throttle setting, and advance toward the jury, positioned as in step b above.

j. Observe and record the distance at which the jury detects the test vehicle visually.

k. Return the test vehicle to its original position.

l. Repeat step i, above, until the jury detects the vehicle aurally.

m. Repeat steps j and k above.

n. Repeat this entire subtest for various gear ranges and throttle settings as deemed appropriate for the particular test vehicle.

NOTE: If standard or developmental detecting devices are available for test support, they will also be used to determine detection distances for the test and comparison vehicles.

o. During the above subtest, note and record the following:

1) Meteorological conditions at the time test is conducted.
2) Light conditions and other conditions affecting visibility.
3) Distance at which torching or other light can be detected.
4) Distance at which both vehicles exhaust smoke or ice fog caused by them can be detected.

6.2.3.8 Weapons Kits Evaluation

NOTE: This subtest is not intended to be a test of a new machine gun or weapon mounted as an integral part of a vehicle, such as tank machine-guns. Testing will be conducted only under arctic winter conditions since summer testing will not yield results different from those in temperate zone tests.

a. Install the weapon kit on the test vehicle in accordance with available instructions, during the pre-operational inspection.

b. Fire the weapon, mounted on the test vehicle, at area targets prior to the start of the mobility subtests and near the completion of the subtests.

NOTE: The weapon shall remain mounted on the test vehicle throughout the test season. During firing, the test weapon shall be fired through all angles of elevation and traverse.

c. Dismount the test weapon upon completion of the test season.

d. Observe and record the following during the conduct of this subtest:

1. The time required to mount and dismount the weapon.
2. Number of crewmen required to mount the weapon.
3. Difficulties encountered in mounting the weapon.
4. Any unusual wear or damage to the weapon or mount during the test.

5. Miles of operation with the kit mounted and the type of terrain operated over.
6. Any incompatibility of the mount and weapon with crew function or the use of other of the test vehicle's equipment.
7. Total number of rounds fired and difficulties encountered during firing.

6.2.4 Performance Characteristics

6.2.4.1 Fuel and Oil Consumption

6.2.4.1.1 Total Fuel and Oil Consumption - The following procedures shall apply:

NOTE: This test shall be conducted during the entire period of arctic tests of the test vehicle.

a. Fill the tanks of the test vehicle with the grade and fuel type specified in the appropriate documentation.

NOTE: If the test vehicle possesses a multi-fuel capability, the primary fuel shall be used during approximately 75% of the accumulated mileage and a minimum of one secondary fuel during the remaining 25%.

b. Record the initial odometer reading of the test vehicle prior to the beginning of testing.

c. Record the final odometer reading of the test vehicle upon completion of testing.

d. Record the total amount of fuel consumed by the test vehicle during the entire testing period.

e. Measure and record total oil consumption during the entire testing period by performing procedures similar to a through d above for oil instead of fuel.

6.2.4.1.2 Cruising Range - The following procedures shall apply:

NOTE: This subtest shall be conducted a minimum of three times during the entire test cycle. One test should be conducted at the beginning of the test cycle; one at the mid-point and one near the end of testing.

a. Fill the fuel tanks of the test vehicle with the appropriate fuel type and record the fuel amount.

b. Operate the test vehicle with rated payload over the road specified in QMR's, SDR's, or other appropriate documentation, until it stops from lack or fuel.

NOTE 1: In the absence of the road condition specified, the test vehicle shall be operated on arctic secondary roads.

NOTE 2: During the conduct of this subtest, the test vehicle shall be halted for 15 minutes each two hours. The engine shall be off during these periods.

c. Record the odometer reading at the beginning and end of this subtest.

d. At the conclusion of the cruising range test, completely fill the test vehicle's fuel tanks to determine the usable fuel capacity.

6.2.4.1.3 Battlefield Consumption - The following procedures shall apply:

NOTE: If the test vehicle requirements contain an operational cycle for typical battlefield day operations of the vehicle, this cycle shall be followed in determining battlefield day fuel and oil consumption rates. In the absence of stated requirements, the test vehicle shall be operated for 18 continuous hours as follows:

(1) Forty percent with engine idling.
(2) Forty percent operating cross-country at 2-½ to 10 miles per hour.
(3) Twenty percent operating on secondary roads at 15 to 20 miles per hour.

a. Fill tanks of the test vehicle with the grade and fuel type specified in appropriate documentation.

b. Record the initial odometer reading prior to operating the test vehicle.

c. Operate the test vehicle for 18 hours as applicable (see note above).

d. Record the final odometer reading of the test vehicle.

NOTE: This test will be repeated three times during the test cycle. In the case of an arctic winter test, it will be conducted in ambient air temperatures below 0°F. One of the three tests will be conducted in ambient air temperatures below -25°F.

6.2.4.2 Fuel and Lubricant Analysis

a. During the conduct of the arctic tests, engine oil from the test vehicle will be sampled at regular intervals to include, but not limited to, the following:

1) Initial sampling of oil to be used during the test.
2) Oil in engine when received at the Arctic Test Center.
3) Prior to all oil changes.
4) After occurrence of any engine failure.
5) Before and after cold start tests (if applicable) on three occasions in ambient temperatures below -25°F.

b. Analyze oil samples by laboratory analysis to determine the amount of oil dilution and metallic or silicon contamination present in the sample. If it appears that metallic contamination is great enough to indicate an imminent engine failure, the engine will be removed and sent to appropriate agencies for a complete teardown inspection.

c. Record the following:

1) Hours and test miles of operation at time sample is taken.
2) Engine operating conditions prior to time sample is taken.
3) Fuel contamination.
4) Water contamination.
5) Metallic and silicon contamination.

6.2.4.3 Tractive Capability

NOTE 1: This subtest will normally not be conducted unless specifically directed by U. S. Army Test and Evaluation Command or the requesting agency in the case of Category II tests. Because of the difficulty in predicting the effect of snow-covered surfaces on test vehicle traction, a comparison vehicle will normally be used and the results compared. If the test and comparison vehicle is equipped with a number of track or track pad configurations, they will be compared. Materiel Test Procedure 2-2-604, Drawbar Pull, shall be used as a guide where applicable.

NOTE 2: Testing shall be conducted on a level snow-covered surface. Data will be collected under the following four conditions:

1) Deep snow in 0°F to -25°F temperature range.
2) Hard-packed snow in 0°F to -25°F temperature range.
3) Deep snow in temperature range -25°F to lowest available.
4) Hard-packed snow in temperature range -25°F to lowest available temperature.

a. Load the test vehicle with its normal payload or to its combat weight.

b. Record the surface conditions in the test area to include the following:

1) Depth of snow.
2) Temperature of snow.
3) Description of cross section of snow.
4) Depth of track or wheel penetration.

c. Conduct a mobile drawbar pull test, utilizing each of the vehicle gear ranges.

NOTE: With the test vehicle traveling a maximum safe speed in the gear range being tested, gradually increase the towed load until the vehicle comes to a halt or the engine stalls.

d. Constantly monitor and record drawbar pull, vehicle speed and track or wheel speed.

e. Record the following additional data:

1) Meteorological conditions
2) Precipitation (if any)

6.2.4.4 Slope Performance

NOTE: This subtest is normally conducted utilizing a comparison vehicle. The test and comparison vehicles will be operated at the same time in the same area to assure valid comparison results. This subtest is not conducted during summer testing because the results will not be different from those determined during temperate zone testing. Testing will be conducted in the temperature ranges of 0°F to -25°F, and -25°F to the lowest available temperature. There will be sufficient snow cover on slope test areas to prevent the wheels or tracks from making contact with the ground surface under the snow.

a. Load the test vehicle to its rated load or combat weight.

NOTE: When the vehicle is required to tow a load, as in the case of a cargo truck, it will be tested both with and without its rated towed.

b. Check the test item's engine, transmission, brakes and other components of the running gear and adjust if required to assure optimum operational characteristics.

c. Attempt to ascend longitudinal slopes of 30, 40, 50 and 60% with the test vehicle.

NOTE: The vehicle will begin its ascent from a halt at the position where the slope changes from the horizontal to the specific slope selected. If the vehicle fails to negotiate the given slope it will immediately make a second attempt.

d. Observe and record the result of ascent attempts.

e. Verify the slope percent with a slope gage.

f. Descend the slope in gear.

g. Observe and record the driver's ability to control the vehicle direction during both ascent and descent.

h. Repeat procedures c through g, until the maximum slope that the vehicle can negotiate is determined. Record this slope.

i. Hold the test vehicle on the maximum slope with the service brakes and then the parking brakes, for a period of 5 minutes, while headed first up the slope and then down the slope.

j. Record any brake slippage noted.

k. Operate the test vehicle on 20 and 30 percent side slopes.

l. Observe and record whether any control problems develop from operation as indicated in k above.

NOTE: During operation of the test vehicle according to k above, the vehicle will be operated first in one direction on the slope and then in the opposite direction to determine if there is any change in controllability because of weight distribution variations.

m. Verify the percent slopes on which the vehicle is operated with a slope gage.

n. Note and record any failure of the engine transmission and brakes to perform properly, during this subtest.

o. In addition to the above data, record the following:

1) Ambient air temperature during testing.
2) Meteorological conditions during testing.
3) Snow conditions on slope.

6.2.5 Mobility

6.2.5.1 Road Mobility

NOTE: If a comparison vehicle is used during the test, all data in this subtest will be recorded for both the test and comparison vehicles. The test and comparison vehicles will be operated at the same time in the same area to assure valid comparison results. The vehicle will carry its rated load during all road mobility testing. If the vehicle normally pulls a towed load, it will be tested both with and without the rated towed load.

a. Operate the test vehicle over an established secondary road course containing straight level stretches, curves, grades and side slopes.

NOTE 1: Include a complete description of the test course utilized, in the final report of test.

NOTE 2: During operation over the above test course, the driver shall maintain maximum safe speeds consistent with road and weather conditions.

b. Observe and record the following data before, during, and after operation of the test vehicle over the test course as indicated below:

1) Record the initial mileage prior to operation.

2) Record the time when the test vehicle starts to negotiate the test course.
3) Record the length of the test course.
4) Record the time when the test vehicle completes the test course.
5) Record, whenever practicable, the acceleration times and distances.
6) Record any emergency stopping times and distances.

c. Determine and record the minimum right and left turning radii of the test vehicle during the summer and winter utilizing a suitable, flat, snow-covered area.

NOTE: Radii of the turns will be measured to the furthest outside projecting and to the nearest inside projection. For tracked vehicles, the test will be conducted at minimum speed, 5 miles per hour and 10 miles per hour. Wheel vehicles will be tested at minimum speed and 5 miles per hour.

d. Accelerate the test vehicle from 0 to 10, 20, 30, etc. miles per hour up to top safe speed.

e. Record the time and distance required to reach each speed.

NOTE: This test will be conducted on snow covered surfaces, twice, during the arctic summer and twice during the arctic winter. Winter tests shall be conducted in temperature ranges of 0°F to -25°F, and -25°F to the lowest available temperature.

f. During operation cause the test vehicle to make a series of emergency steps from 10, 20, 30, etc. miles per hour, up to the maximum safe speed.

g. Note and record the time and distance at which braking is initiated, for each speed and temperature/snow condition.

h. Record the time and distance at which the test vehicle comes to a complete stop.

i. Fully equip and man the test vehicle for a tactical operation.

j. Operate the test vehicle as part of a convoy on arctic secondary roads.

k. Observe and record the ability of the test vehicle to maintain its position within the convoy, and to maintain the prescribed speed.

NOTE: The test vehicle will occupy various positions within the convoy, to include lead and last position. It will be operated both in daylight and in hours of darkness. Blackout driving conditions will be utilizing a portion of the time when the test is conducted during hours of darkness.

l. In addition to the above mentioned data, the following data shall be recorded during the conduct of this subtest:

1) Operator comments concerning maneuverability, stability,

ease of ride, braking and steering ability of the test vehicle during the test conduct.
2) Ambient meteorological conditions present during testing.
3) Conditions of roads and hardstand.
4) Description of the test course.
5) Adverse effects of ice fog, if any, on the test vehicle during conduct of this subtest.

6.2.5.2 Cross-Country Mobility

NOTE: See note under 6.2.4.1.

a. Operate the test vehicle over an established cross country course.

NOTE 1: The cross country course shall consist of cross-country trails including longitudinal and side slopes, curves, and minor obstacles.

NOTE 2: Include a complete description of the test course utilized, in the final report of test.

NOTE 3: Drivers shall maintain maximum safe speed, limited by vehicular safety or the ability of crewmen to perform their duties at their normal duty stations.

b. Observe and record the following data before, during and after operation of the test vehicle over the prescribed test course, as indicated below:

1) Record the initial mileage prior to operation.
2) Record the time operation of the test vehicle along the test course.
3) Record the length of the test course.
4) Record all obstacles that immobilize the test vehicle during operation.
5) Record a description of the test course.
6) Record a description of cross-section of snow drifts negotiated and the maximum snow depth and muskeg negotiated by the test vehicle.
7) Record observations pertaining to maneuverability, stability, ease of steering, ease of ride and braking capability of the test vehicle.

c. Operate the test vehicle over cross-country terrain not encountered on the cross country course, to determine what obstacles cannot be negotiated.

NOTE: The operation mentioned in c above shall include various depths of muskeg and snow, sand and rocky areas, timber,

brush, hummocks or logs, and shall be conducted once during breakup, once after breakup and twice during the winter in ambient temperatures of 0°F to -25°F and -25°F to the lowest available temperature.

d. Record data as indicated in b above.

NOTE: During the winter, this subtest, with the exception of c above, shall be run on snow covered surfaces a minimum of three times in ambient temperatures below 0°F. One of the three trials will be in ambient temperatures below -25°F. During the summer, the course will be run once during breakup conditions (normally May) and twice after breakup (normally June or July).

6.2.5.3 Inland Waterways Operation

NOTE: This subtest will normally be conducted only with amphibious vehicles undergoing arctic summer tests. If specifically requested by U. S. Army Test and Evaluation Command or the Category II test request agency, it may be conducted during arctic winter testing, if unfrozen waterways are available. Testing will be conducted both in Bolio Lake and the Delta River just prior to a quarterly maintenance inspection of the vehicle. Safety precautions will be strictly adhered to during this test. The test vehicle crew will wear life jackets and cables will be attached to the front and rear of the test vehicle to assist in recover, if required. A recovery vehicle will be on standby at the test site. All operations will be in accordance with operating manuals for the test vehicle. The test vehicle will be loaded to its rated load or combat weight.

a. Operate the test vehicle in the manner prescribed in appropriate operating manuals on the chosen waterway.

b. Observe and record the following:

1) The maximum safe speed that can be achieved in various currents.
2) Maneuverability.
3) Adequacy of freeboard.
4) Adequacy of vision (with hatches open and closed, if applicable).
5) Attitude of the test vehicle in the water.
6) Adequacy of provisions for evacuation of crew or passengers in event of sinking.
7) Adequacy of bilge pumps. If pumping is not required during test operations, water will be introduced into the test vehicle and the pumps operated.

8) The slope and condition of banks that can be negotiated when entering and leaving the water.
9) Adequacy of operating instructions and difficulties in preparing the test vehicle for water operation and returning it to condition for land operation.

NOTE: Following testing the test vehicle will undergo a quarterly maintenance inspection and the effect of water on sealing, lubrication, fuel supply, power train and other vehicular components will be evaluated.

10) Velocity of stream current.
11) Maximum speed of test vehicle when moving perpendicular to the current.
12) Condition of banks and the maximum slope that may be negotiated when entering or leaving the water.
13) Time to prepare test vehicle for water operation.
14) Time to prepare test vehicle for land operation after operating in water.

6.2.5.4 Fording

NOTE: This sub-test will normally be conducted only on vehicles undergoing arctic summer tests. If specifically requested by U. S. Army Test and Evaluation Command or the Category II test request agency, it may be conducted during arctic winter tests, if unfrozen waterways are available. Shallow fording tests only will be conducted at this Center. Shallow fording applies to standard tactical vehicles operating without the addition of kits. During fording operations safety precautions will be strictly adhered to. The test vehicle crew will wear life jackets and cables will be attached to the front and rear of the test vehicle to assist in recovery if required. A recovery vehicle will be on standby at the test site. The fording area will be probed prior to and during fording operation to insure that the test vehicle does not drop into deep holes. All operations will be in accordance with operating manuals for the test vehicle. The test vehicle will be loaded to its rated load or combat weight. Testing will be conducted just prior to a quarterly maintenance inspection.

a. Operate the test vehicle without any special preparation, for a minimum of 30 minutes in a hard bottomed stream to the depth of water specified in the applicable QMR, SDR, or TC.
b. Observe and record the following:

1) The maximum entry and exit slopes which may be negotiated will be measured with a slope gage.

2) Effects of spray or splash at various speeds.
3) Effects of ice formation, if applicable.
4) Ability of driver to control the test vehicle.
5) Water leaks into the crew compartment(s).

NOTE: Following operation in water, the test vehicle will undergo a quarterly maintenance inspection and the effect of water on sealing, lubrication, fuel supply, power train and other vehicular components will be evaluated.

6) Depth of water forded.
7) Condition of the stream bed and velocity of stream current.
8) Condition of banks and the maximum slope that can be negotiated when entering or leaving the water.
9) Effect of water on the test vehicle's components.

6.2.6 Human Factors Evaluation and Safety

a. Conduct all Human Factors and Safety tests in accordance with the applicable sections of MTP 10-4-500.

b. Conduct these tests concurrently with the operational tests described in this MTP.

c. Complete check lists A and B in this MTP.

6.2.7 Maintenance Evaluation

a. Conduct all maintenance evaluation tests (maintenance and reliability) in accordance with applicable sections of MTP 10-4-500.

b. Conduct these tests concurrently with the operational tests described in this MTP.

c. Complete check list C.

6.3 TEST DATA

All test data to be recorded will be as specified in the individual subtests of MTP.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 General

a. Still and motion pictures, obtained during testing shall be collected, reviewed and placed with other data collected during other subtests.

b. A list shall be prepared containing any unnecessary, costly, or nice-to-have features that may be eliminated without adversely affecting essential performance requirements, reliability, quality or safety.

c. Processing of raw test data shall, in general, consist of organizing, marking for identification and correlation, and grouping the test data according to test title.

d. Specific instructions for the reduction and presentation of individual test data are outlined in succeeding paragraphs.

6.4.2 Preoperational Inspection and Physical Characteristics

Reduce and prepare data in accordance with MTP 10-4-500.

6.4.3 Operational Suitability

6.4.3.1 Cold Starting

6.4.3.1.1 Engineering Cold Starts - Reduce and present data as follows:

a. Evaluate data recorded in 6.2.3.1.1 and make a determination of the ability of the test vehicle to start under various conditions of the arctic environment, using the starting procedure recommended in the operator's manual or provided by the developer, within the prescribed time interval.

b. Present data evaluated, as indicated above, in terms of a statement and appropriate backup data attesting to the adequacy of starting procedures prescribed in operator manuals or as provided by the developer, or in terms of a recommended starting procedure.

6.4.3.1.2 Service Cold Starts - Reduce and present data as follows:

a. Evaluate data recorded in 6.2.3.1.2 and make a determination of the ability of the test vehicles electrical system to start the engine under arctic winter conditions without the use of external power sources.

b. Present data evaluated in terms of a statement and appropriate backup data attesting to the adequacy of the test vehicles electrical system for starting the test vehicle under specified arctic conditions.

6.4.3.1.3 Cooldown Rate - Reduce and present data as follows:

a. Utilizing data recorded in 6.2.3.1.3, determine the rate at which various vehicular components cool down when exposed to ambient temperatures below -25°F.

b. Utilizing the cooldown rate as obtained above, determine the length of time the test vehicle may be subjected to prevailing weather conditions before starting aids are required.

c. Compare the cooldown rate established for various components of the test vehicle, with rates prescribed in QMR's, SDR's, TC's, or other applicable documentation and determine if acceptable.

6.4.3.2 Suitability of Crew Heater System

a. Determine and present data collected in 6.2.3.2 in terms of the following:

1) Warmup characteristics of vehicular compartments.
2) Adequacy and uniformity of heat distribution to compartments at the feet, hands and face levels.
3) Window defrost capability of the heater system.

b. Compare data presented above with prescribed data values and determine if acceptable.

6.4.3.3 Suitability of Special Purpose Kits

a. From data collected in 6.2.3.3, determine the functional suitability of special purpose kits and the compatibility of the kits with the test vehicle.

b. From data collected in 6.2.3.3, determine whether the special purpose kits may be installed by personnel at the prescribed maintenance level.

c. Compare values and other data determined above with prescribed standards and determine the special purpose kits are acceptable.

6.4.3.4 Stowage

a. Evaluate data collected in 6.2.3.4, and determine whether stowage provisions are adequate for all materiel carried in or on the test vehicle when operated in an Arctic environment.

b. Compare stowage adequacy determination data, with stowage requirements as specified in appropriate documents and determine whether stowage provisions of the test vehicle are adequate.

6.4.3.5 Compatibility with Related Equipment

a. Determine, from data collected in 6.2.3.5, whether the test vehicle is compatible with related vehicles and equipment.

b. Compare compatibility data with prescribed or specified compatibility criteria and determine whether the test vehicle is acceptable for arctic use in terms of its compatibility characteristics.

6.4.3.6 Functional Suitability

6.4.3.6.1 Combat Vehicles - Reduce and present data as follows:

Determine by evaluating the data collected in 6.2.3.6.1 whether combat vehicles can adequately perform their designated functions under arctic conditions.

6.4.3.6.2 Logistical or Administrative Vehicles - Reduce and present data as follows:

Determine by evaluating data collected in 6.2.3.6.2, whether combat vehicles can adequately perform their designated functions under arctic conditions.

6.4.3.7 Security from Detection

a. Evaluate data collected in 6.2.3.7 and determine the susceptibility of the test vehicle to detection.

b. Determine whether security from detection characteristics of the test vehicle are such as to make the test vehicle acceptable to use under arctic conditions.

6.4.3.8 Weapons Kit Evaluation

a. From data collected in 6.2.3.8, determine the compatibility of the weapons kit with the test vehicle and crew under arctic conditions.
b. Determine the time, tools and skill level required to install and remove the weapons mount or weapon under arctic conditions.
c. Compare values determined in b above, with prescribed or specified values and determine whether the weapons kit is acceptable for arctic usage.

6.4.4 Performance Characteristics

6.4.4.1 Fuel and Oil Consumption

6.4.4.1.1 Total Fuel Consumption - Reduce and present data as follows:

a. Reduce data collected according to 6.2.4.1.1, pertaining to fuel, to an overall fuel consumption rate in miles per gallon.
b. Reduce data collected according to 6.2.4.1.1, pertaining to oil, to an overall oil consumption rate in miles per quart.
c. Compare the determined oil and fuel consumption rates to prescribed rates and determine whether acceptable.

6.4.4.1.2 Cruising Range - Reduce and present data as follows:

a. Same as 6.4.3.1.1 a, for cruising range.
b. Same as 6.4.3.1.1 b, for cruising range.
c. Same as 6.4.3.1.1 c, for cruising range.

6.4.4.1.3 Battlefield Consumption - Reduce and present data as follows:

Determine battlefield consumption rate of oil and fuel from data collected in 6.2.4.1.3 and compare consumption rates with optimum or prescribed rates in order to determine acceptability.

6.4.4.2 Fuel and Lubricant Analysis

a. Determine from the analysis performed in 6.2.4.2 on fuel and oil samples, the extent of crankcase oil dilution by water and fuel.

6.4.4.3 Tractive Capability

Determine from data collected in 6.2.4.3, the tractive effort capability of the test vehicle on snow covered surfaces under arctic winter conditions.

6.4.4.4 Slope Performance

a. Determine from data collected in 6.2.4.4, the maximum snow-covered longitudinal slope that the test vehicle is capable of ascending and descending under arctic winter conditions.

b. Determine from collected data, the ability of the test item to operate on snow covered side slopes under arctic winter conditions.

c. Determine from collected data, the brake holding ability of the test vehicle on snow covered slopes under arctic winter conditions.

6.4.5 Mobility

6.4.5.1 Road Mobility

Determine from data collected in 6.2.5.1, the road mobility characteristics of the test vehicle when operated under arctic conditions.

6.4.5.2 Cross Country Mobility

Determine from data collected in 6.2.5.2, the cross country mobility characteristics of the test vehicle when operated under arctic conditions.

6.4.5.3 Inland Waterways

Determine from data collected in 6.2.5.3, the effects of arctic water operation on the operational characteristics of the test vehicle.

6.4.5.4 Fording

Determine from data collected on 6.2.5.4, the fording capability of the test vehicle under arctic conditions.

6.4.6 Human Factors Evaluation and Safety

Reduce data and prepare in accordance with MTP 10-4-500. Reduce data from check list and evaluate in accordance with stated requirements of QMR's and TC's.

6.4.7 Maintenance Evaluation

Reduce data and prepare in accordance with MTP 10-4-500. Reduce data from check list and evaluate in accordance with stated requirements of QMR's and TC's.

APPENDIX A

HUMAN FACTORS ENGINEERING CHECK LIST

FOR MILITARY TACTICAL WHEELED VEHICLES

SECTION I - VEHICLE DESIGN

1. SEATS. Driver and crew seats are adjustable for tall and short men and are contoured to fit the back and buttocks of the average man.

2. CONTROLS.

a. The steering control-operator seat relationship shall permit safe, easy, and comfortable driving.

b. The control requires as few movements as possible.

c. Successive control movements are interrelated; i.e., one movement passes easily into the next.

d. Controls used in rapid sequence have uniform direction of motion.

e. Control movements are consistent for all equipments which one operator uses.

f. The method used to prevent accidental activation of the control, if any, does not increase the time required to operate the control to such an extent that it is unacceptable.

g. Activation of the control does not obscure visual display or control markings.

h. Controls such as clutches and foot throttles are located in such a manner that they can be operated easily without the driver having to assume uncomfortable body angles. Controls of this type are also capable of operated easily when the driver is equipped with thermal insulated boots.

i. Foot throttles are so located that the driver, with minimum amount of movement and effort, can remove his foot from the throttle and apply the foot brake.

j. The driver has the capability of applying the brakes easily when thermal boots are worn.

k. The instrument panel is so located that it can be observed from the normal driving position.

l. A master warning light is provided for notification when engine temperature, oil pressure, etc., are above or below safe operating ranges.

3. DISPLAYS

a. Information presented is necessary for the decisions or actions required of the operator.

b. Information is presented in the most immediately meaningful form; i.e., no interpretation of decoding is required.

c. Information is displayed to the accuracy required by the decisions or actions of the operator, and preferably no more accurately than required.

d. If scale interpolation is required, it does not introduce a probability for operator errors which are greater than the operator's task permits.

e. Information for different types of activities; e.g., operation and maintenance, is not combined unless the activities require the same information.

f. Information is current; i.e., lag is minimized.

g. Failure in the unit is clearly shown or the operator is otherwise warned.

h. A warning device is provided to indicate when the emergency brake is on.

i. For bulk refuelers, instructions for operation are placed conspicuously on the equipment.

4. MISCELLANEOUS

a. Adequate means are provided for the driver to get in and out of the cab when wearing cold-weather clothing.

b. Adequate means are provided for troops to mount the rear of trucks with maximum ease.

c. Nonskid decking is provided for safety.

d. OEM tools are located where they are easily accessible to drivers.

e. Power-assist steering is provided for vehicles having a weight-carrying capacity of 5 tons and above.

f. Tailgates on trucks, 2-1/2 tons and over, incorporate an equilibrator that slow their movements to the down position and assist their movement to the closed position.

g. Safety straps are placed in vehicles that do not have doors on the driver or passenger side. They are also required for the safety of passengers in the cargo compartment.

h. Whenever possible, trucks have drop sides for ease of loading. Means should be provided to permit ease of lowering and raising.

i. For bulk refuelers, fire extinguishers are placed at an easily accessible location, and that location is one where fire is not likely to start.

SECTION II - MAINTAINABILITY DESIGN

1. HANDLES.

a. When possible, handles are provided on covers, drawers, and components to facilitate handling.

b. When handles cannot be provided, hoist and lift points are clearly marked.

c. When possible, handles are located over the center of gravity to prevent the object from tipping while being lifted or carried.

d. Handles are positioned so that they cannot catch on other unit, wiring, protrusions, or structural members.

2. COVERS, CASES, and ACCESS DOORS.

a. Method of opening a cover is evident from the construction of the cover itself. If not, an instruction plate is permanently attached to the outside of the cover.

b. Hinges are used, where possible, to reduce the number of fasteners required.

c. When a hinged cover is used, a space equal to the swept volume of the cover is provided; e.g., opening of the cover is not obstructed by bulkheads, brackets, etc.

d. Structural members, other components, etc., do not interfere with removal of a cover.

e. Provision has been made for adequate bonding of plastic or rubber stripping and seals, so that if a cover comes into contact with, or must slide over such material, the seal will not be damaged or the cover jammed.

f. It is evident when the cover is in place but not secured.

g. Where feasible, guides, tracks, and stops are provided to facilitate handling and to prevent damage to components.

h. Access doors are hinged at the bottom if possible.

i. When access doors must be hinged at the top, a support rod is provided to hold the cover open.

j. Hinged doors or covers are provided with captive, quick-opening fasteners.

k. If instructions applying to a covered unit are lettered on a hinged door, the lettering is properly oriented for reading when the door is open.

l. A minimum number and type of fasteners are used, commensurate with requirements for compensating for stress, bonding, etc.

m. When possible, the same size and type of fasteners are used for all covers, cases, and access doors.

n. Maximum use is made of tongue-and-slot catches to minimize the number of fasteners required.

o. Hand-operated fasteners requiring no tools are preferred: those requiring standard hand tools are acceptable; those requiring nonstandard tools should not be used.

p. Captive nuts and bolts are used where feasible.

3. ACCESSIBILITY.

a. Information placed at each access includes the following:

(1) Nomenclature of items accessible through it.
(2) Warnings of hazardous or critical operations.

b. Edges of accesses have internal fillets or other protection if they might otherwise cause injury to hands or arms.

c. Access provisions are located on easily accessible surfaces.

d. Components are not placed in recesses or located behind or under stress members, floor boards, seats, hoses, pipes, or other items which are difficult to remove.

4. LOCATION OF REPLACEABLE COMPONENTS.

a. Large components which are difficult to remove are mounted so that they do not prevent access to other components.

b. Components are located so that each replacement unit can be removed through a single access panel.

c. Components are placed to allow sufficient space for use of test equipment and other required tools without difficulty or hazard.

d. All throwaway components are accessible without removal of other components.

e. Structural members of the chassis do not prevent access to components.

f. Delicate components are so located or guarded that they will not be damaged while the unit is being handled or worked on.

g. Components are located so that blind adjustments are not necessary.

h. Components of the same or similar form, such as seals, are mounted with a standard orientation throughout, but are readily identifiable and distinguishable.

i. Equipment is modularized so that rapid and easy removal and replacement of malfunctioning modules or components can be accomplished by one technician.

j. Component can be checked and adjusted separately and then connected together into the system with minimum adjustment.

5. COMPONENT MOUNTING.

a. Whenever possible, components are so located that no other equipment must be removed to gain access or to remove them.

b. If it becomes necessary to place one component behind another, the component requiring less frequent access is in the rear.

c. Components frequently removed for checking from their normal installed position are mounted on rollout racks, slides, or hinges.

d. Limit stops are provided on rollout racks and drawers; override of these limit stops is easily accomplished.

e. Field removable components are replaceable with common handtools.

f. Components are mounted to the housing rather than attached to each other so only the component to be replaced has to be removed.

g. Removal of any replaceable component requires opening or removal of a minimum number of covers or panels (preferably one).

h. Components are laid out so that a minimum of place-to-place movement by the operator is required during checkout.

i. Components are located and mounted so that access to them may be achieved without danger to personnel; e.g., from electrical charge, heat, sharp edges and points, moving parts, chemical contamination.

j. Access to units maintained by one operator do not require removal of equipment by a second higher skilled operator.

6. CONDUCTORS, CABLES, AND CONDUITS.

a. Long conductors, cables, and conduits internal to equipment, are secured to the chassis by cable clamps.

b. Cables are long enough so that each functioning component can be checked in a convenient place or, if this is not feasible, extension cables are provided.

c. Cables are long enough to permit jockeying or movement of components when it is difficult to connect or disconnect other cables.

d. Cables and conduits are routed so they cannot be walked on or used for handholds.

e. Cables and conduits are easily accessible for inspection and repair.

f. Cables and conduits are so routed that they need not be bent or twisted sharply or repeatedly.

g. If feasible, individual conductors of all cables, either single- or multi-conductor, are color coded their entire length.

7. CONNECTORS

a. One-turn or other quick-disconnect plugs are used.

b. When dirt and moisture are a problem, plugs have an attached cover.

c. Connectors are located far enough apart so that they can be grasped firmly for connection and disconnection.

d. Rear of plug connectors is accessible for test and service, except where this is precluded by potting, sealing, etc.

e. Plugs or receptacles are provided with aligning pins or other alignment devices.

f. Plugs are designed so that it is impossible to insert the wrong plug in a receptacle.

g. Socket rather than plug contacts are "hot".

h. Connectors and their associated labels are positioned for full view by maintenance personnel.

i. Connecting plugs and receptacles are identified by color or shape or other acceptable means.

j. Plugs and receptacles have painted stripes, arrows, or other indications to indicate proper insertion of aligning pins.

8. TEST POINTS

a. Test points to determine that a unit is malfunctioning are provided.

b. Appropriate test points are provided when a component is not completely self-checking.

c. First echelon test points are so located and coded that they are readily distinguished from higher echelon test points.

9. FUZES AND CIRCUIT BREAKERS

a. Fuzes and circuit breakers are so located that they can be easily seen and quickly replaced or reactivated.

b. Fuze replacement is not hampered by other components.
c. No special tools are required for fuze replacement.

10. ON-EQUIPMENT TOOLS.

a. Variety of tools is held to a minimum.
b. As few special tools as possible are required.
c. Tools are of dull finish to avoid glare in strong light.
d. Speed and ratchet-type tools are provided when necessary.
e. Nonsparking tools are provided for use in an explosive atmosphere.

11. LUBRICATION.

a. Equipment containing mechanical components either has provision for lubrication without disassembly or does not require lubrication.
b. When lubrication is required, the type of lubricant to be used and the frequency of lubrication is specified by a label at or near the lubrication point.

APPENDIX B

HUMAN FACTORS ENGINEERING CHECK LIST

FOR COMBAT TRACKED VEHICLE

SECTION I - VEHICLE DESIGN

1. SEATS. Driver and crew seats are comfortable and adjustable to give proper support and normal operating range to hand and foot controls and vision devices.

2. HATCHES.

a. All normal entry and exit hatches are free from obstruction, operate easily, and possess the proper means of latching and securing.

b. An adequate alternate emergency exit is provided.

3. CONTROLS.

a. The steering control-operator seat relationship shall permit safe, easy, and comfortable driving.

b. The most important and most frequently used controls are located in the optimal manual areas.

c. The location of any control does not obstruct the operation of, or visual angle to, any frequently used control or indicator.

d. Spacing between controls is sufficient to obviate accidental activation during operation.

e. All primary and emergency controls are easily identifiable both visually and nonvisually.

f. Continuous controls should provide operating resistance consistent with performance requirements for speed, accuracy, and smoothness of operation.

g. Discrete controls provide positive stop action such as detects or clicks.

h. Controls requiring crewmembers to reach with hand or foot are sufficiently adjustable when seat adjustment is insufficient to allow operator comfort for all operations.

i. Control-display relationships are consistent with psychiological expectations.

j. All controls can be operated by personnel wearing arctic winter clothing.

k. All controls are physically designed to withstand the abuse of emergency and accidental movement.

l. Safety controls are provided to prevent accidental operation and/or stop immediately any accidental or hazardous operation.

m. Successive control movements are interrelated; i.e., one movement passes easily into the next.

n. Controls used in rapid sequence have uniform direction of motion.

o. The control sequence required as few movements as possible.

4. DISPLAYS.

a. Information presented is necessary and presented in immediately meaningful form.

b. Information for different types of activities; e.g., operation and maintenance is not combined unless th activities require the same information.

c. Information is current; i.e., lag is minimized.

d. Failure in the unit is clearly shown or the operator is otherwise warned.

e. The display can be read easily from the normal operator location.

f. Contrast ratio and illumination of controls and/or displays is sufficient under all expected light conditions.

g. Displays are labeled consistently.

h. Displays are located so as to require minimum eye movement when the operator is performing his primary task.

5. MISCELLANEOUS.

a. Vibration and noise is kept below levels that might impair efficiency of crewmembers.

b. Ventilation is adequate and the intake or generation of obnoxious or toxic fumes in crew compartments is avoided.

c. Vision characteristics are of the maximum degree and field of view possible in consonance with crewmembers' station, task requirement, and body conformation.

d. All possible devices for crew safety are provided.

e. Light brightness on all lights is continuously adjustable through the entire range.

SECTION II - MAINTAINABILITY DESIGN

1. COVERS, CASES, AND ACCESS DOORS.

a. Hinges are used, where possible, to reduce the number of fasteners required.

b. Structural members, other components, etc., do not interfere with removal of a cover.

c. Provision is made for adequate bonding of plastic or rubber stripping and seals, so that if a cover comes into contact with, or must slide over such material, the seal will not be damaged or the cover jammed.

d. Where feasible, guides tracks, and stops are provided to facilitate handling and to prevent damage to components.

e. Hinges doors or covers are provided with captive, quick-opening fasteners.

f. A minimum number and type of fasteners are used, commensurate with requirements for compensating for stress, bonding, etc.

g. When possible, the same size and type of fasteners are used for all covers, cases, and access doors.

h. Maximum use is made of tongue-and-slot catches to minimize the number of fasteners required.

i. Captive nuts and bolts are used where feasible.

2. ACCESSIBILITY.

a. Information placed at each access included the following:

(1) Nomenclature of items accessible through it.
(2) Warnings of hazardous or critical operations.

b. Edges of accesses have internal fillets or other protection if they might otherwise cause injury to hands or arms.

c. Access provisions are located on easily accessible surfaces.

3. CONDUCTORS, CABLES, AND CONDUITS.

a. Long conductors, cables, and conduits internal to equipment, are secured to the hull by cable clamps.

b. Cables are long enough so that each functioning component can be checked in a convenient place or, if this is not feasible, extension cables are provided.

c. Cables are long enough to permit jockeying or movement of components when it is difficult to connect or disconnect other cables.

d. If it is necessary to route cables, wires, and conduits through holes in metal partitions, protection from mechanical damage is provided by grommets or other acceptable means.

e. Cables and conduits cannot be pinched by doors, lids, etc.

f. Cables and conduits are routed so they cannot be walked on or used for handholds.

g. Cables and conduits are easily accessible for inspection and repair.

h. Cables and conduits are so routed that they need not be bent or twisted sharply or repeatedly.

i. If feasible, individual conductors of all cables, either single- or multi-conductor, are color coded their entire length.

4. CONNECTORS.

a. One-turn or other quick-disconnect plugs are used.

b. When dirt and moisture are a problem, plugs have an attached cover.

c. Connectors are located far enough apart so that they can be grasped firmly for connection and disconnection.

d. Rear of plug connectors is accessible for test and service, except where this is precluded by potting, sealing, etc.

e. Plugs or receptacles are provided with aligning pins or other alignment devices.

f. Plugs are designed so that it is impossible to insert the wrong plug in a receptacle.

g. Socket rather than plug contacts are "hot".

h. Connectors and their associated labels are positioned for full view by maintenance personnel.

i. Connecting plugs and receptacles are identified by color or shape or other acceptable means.

j. Plugs and receptacles have painted stripes, arrows, or other indications to indicate proper insertion of aligning pins.

5. TEST POINTS.

a. Test points to determine that a unit is malfunctioning are provided.

b. Appropriate test points are provided when a component is not completely self-checking.

c. First echelon test points are so located and coded that they are readily distinguished from higher echelon test points.

6. FUZES AND CIRCUIT BREAKERS.

a. Fuzes and circuit breakers are so located that they can be easily seen and quickly replaced or reactivated.

b. Fuze replacement is not hampered by other components.

c. No special tools are required for fuze replacement.

7. ON-EQUIPMENT TOOLS.

a. Variety of tools is held to a minimum.

b. As few special tools as possible are required.

c. Tools are of dull finish to avoid glare in strong light.

d. Speed and ratchet-type are provided when necessary.

8. LUBRICATION.

a. Equipment containing mechanical components either has provision for lubrication without disassembly or does not require lubrication.

b. When lubrication is required, the type of lubricant to be used and the frequency of lubrication is specified by a label at or near the lubrication point.

APPENDIX C

PARTS ANALYSIS CHART

INSTRUCTION SHEET

GENERAL: Parts will be entered on this chart by functional groups and in numerical order within groups.

DESCRIPTION

COLUMN

1 Record one of the following: Federal Stock Number, Technical Service Part Number, Manufacturer's Part Number, or Drawing Number in this order of preference. (Enter in parenthesis the number of parts replaced below the prescribed part number entry, such as "(1 ea)".)

2 Noun Nomenclature. Self-explanatory. (Enter the nomenclature as given in the parts manual which may differ from the nomenclature entered on the Maintenance and Reliability Analysis Chart from the MAC).

3 Maintenance Level, Prescribed. Maintenance level as prescribed by the parts list under review; O/C - Operator/Crew; O - Organizational; DS - Direct Support; GS - General Support. (For parts which do not have a prescribed maintenance level at which they are to be replaced enter "Not Prescribed". For parts replaced during repair operation use the same maintenance level as prescribed in the MAC for the repair operation.)

4 Maintenance Level, Recommended, O/C, O, DS, or GS indicate maintenance level recommended by the test agency.

5 Life. The number of hours, miles, or rounds accumulated before or since this part was replaced. An entry in this column is made for each part used followed by the appropriate life unit; i.e., M, H, or R. (Enter the true part life. This part life must agree with the part life entry in the EPR submitted.)

6 Reason Used. The symbol "Unsched" will be shown in this column if the part was used as a result of unscheduled maintenance. If the part used was the result of scheduled maintenance, the symbol "Sched" will be used. If the part was consumed to verify procedures or tools, not as a result of breakdown, the symbol "Sim" will be used.

7 Group Number, Cross Reference. Parts usage by maintenance operation is indicated by cross referencing to the group number from Column 1 of the Maintenance and Reliability Analysis Chart.

8 Remarks. If the part usage is related to any other subtest covered in the body of the test report, the paragraph number for cross reference is indicated. If an EPR is related to the part used, the EPR number will be inserted in this column. Enter "Failure" if the operation was performed to correct a malfunction which has been designated as a failure. (The entry in column 8 should be identical to the corresponding entry made on the Maintenance and Reliability Analysis Chart).

CHART 1.--Parts Analysis

FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL O/C - Operator/Crew O - Orgzn DS - Direct GS - General		LIFE M - Miles H - Hours R - Rounds	REASON USED	GP NO. CROSS REF.	REMARKS
		PRESCRIBED	RECOMMENDED				
1	2	3	4	5	6	7	8